REMARKS

In response to the Office Action dated 18 October 2007, Applicant offers the following Amendment and Remarks. Reconsideration and reevaluation is respectfully requested.

Examiner rejected claims 1-6, 11-17, 20 and 22 under 35 U.S.C. 102(b) as being anticipated by Allamon (2003/0024706).

Examiner also rejected claims 7-10 under 35 U.S.C. 103(a) as being unpatentable over Allamon in view of Pia *et. al.* (5,890,540) or McGarian *et. al.* (6,713,795).

Finally, Examiner rejected Claim 7 under U.S.C. 112, second paragraph as being indefinite for failing to point out and distinctly claim the subject matter which the Applicant regards as the invention.

The Applicant has amended independent Claims 1 and 14 to distinguish from the disclosure of Allamon, and submits that the new claims are allowable.

In more detail, Claim 1 has been amended to add two new paragraphs which clearly specify the relationship between the engagement mechanism and the obturating member, thereby further distinguishing between the effects of upward stroking and downward stroking of the tool in comparison to Allamon.

Specifically, a paragraph has been added to old Claim 1 specifying that, with the engagement mechanism in the disengaged configuration and the obturating member in the first position, an upstroke of the tool, putting the tool in tension, moves the obturating member to the second position, thereby permitting fluid flow through the second outlet.

A further paragraph has been added to old Claim 1 specifying that, with the engagement mechanism in the disengaged configuration and the obturating member in the second position, a

downstroke of the tool, putting the tool in compression, moves the obturating member to the first position, thereby closing the second outlet.

Claim 14 has been similarly amended. Specifically old paragraph (c) has been deleted and replaced with new paragraphs (c) and (d). New paragraphs (c) and (d) set out steps in the method corresponding to the features of stroking the tool in Claim 1 up and down, in order to move the obturating member to the respective second or first position.

Support for these amendments is found at page 13, lines 9, 10, 15-20 and 26-30 and at page 14, lines 6-32, of the Application as originally filed.

The Applicant submits that the invention of new Claims 1 and 14 is novel and inventive over Allamon, taken singly or in combination. In more detail, the invention of new Claim 1 relates to a tool for circulating fluid in a well bore. As will be understood from the description, the tool 10 includes an obturating member (which, in an exemplary embodiment, takes the form of a collet assembly 64); a restraining means (which, in an exemplary embodiment includes collet sprung pins 66); and an engagement mechanism (which, in an exemplary embodiment, includes collet support sleeve 78 and index sleeve 98). Tool 10 is connected at its upper end 12 to a work string via box section 16, and is connected to a work string at bottom sub 52 via pin section 54. The collet assembly 64 is thereby coupled through bottom sub 52 into a work string.

In use of tool 10, as described particularly at page 12, line 13 to page 14 line 32 as filed, the tool is run into a well bore with sprung pins 66 located in recess 34 and held in position by collet support sleeve 78. In this position, ports 68 in collet assembly 64 are misaligned with ports 38 in a body of the tool, such that there is no circulating flow radially through the tool.

When it is desired to open such flow, it is necessary to first move the actuation sleeve 78 to release the sprung pins 66. This is achieved by bleeding pressure off from a pressure actuation

surface 88 on actuator sleeve 84, such that sleeve 78 moves upwardly. Index pins 28 then move from position 108 to position 110.

However, this does not cause the sprung pins 66 to move to a second recess 36, aligning ports 68 and 38. This alignment is achieved by selectively stroking the work string up. This upstroke places the tool in tension, such that bottom sub 52 transmits a force to the collet assembly 64, moving it to a position where the sprung pins 66 locate in a recess 36 and ports 68 and 38 are aligned. This movement is held by engagement of index pins 28 in the positions 112.

Fluid pressure is then exerted again on surface 88 of sleeve 84, to move the collet support sleeve 78 downward, thereby retaining the sprung pins 66 in the recess 36. This movement is held by engagement of index pins 28 in the positions 112. The ports are then aligned and flow radially can be achieved.

Equally, when it is desired to return the sprung pins 66 to recess 34, to misalign the ports and stop radial flow, it is necessary to move the sleeve 78 and to stroke the work string down, placing the tool in compression, such that the bottom sub 52 transmits a force to the collet assembly 64. This downstroke moves the sprung pins into recess 34. The sleeve 78 can then be cycled down, by fluid pressure, to the position of Fig 1, to retain the sprung pins in the recess 34.

This is clearly not the case in the tool disclosed in Allamon, where movement of a valving sleeve 141 opens fluid communication between flow ports 135, 136 in the sleeve 141 and flow holes 126 in a body of the tool. As discussed at page 5, paragraphs 64-69 of Allamon, this movement is achieved by successive pressure fluctuations (by landing a ball on a seat 110) and successively moving the sleeve 141 down. This is assisted by movement of a cam sleeve of an indexing mechanism, to progressively support and de-support pivoting latch fingers 114, 115.

Nowhere in Allamon is it taught that variation of fluid pressure on the seat 110 controls

actuation of the indexing mechanism (which the examiner presumably likens to the claimed engagement mechanism) and that stroking the tool, placing the tool in tension, in a disengaged position of the valve sleeve 141 moves the sleeve (which the examiner presumably likens to the claimed obturating member). Indeed, the Applicant notes that stroking the tool, placing the tool in tension, would have no effect whatsoever on the alignment of the flow ports 135, 136 with the housing flow holes 126.

The Applicant therefore reiterates that the invention defined by new Claims 1 and 14 is novel and inventive over Allamon (2003/0024706) and submits that Examiner's rejection of Claims 1 and 14 should be withdrawn.

Claims 2-13 are ultimately dependent on Claim 1, and Claims 15-17 and 20 are ultimately dependent on Claim 14. Applicant therefore submits that these claims are ultimately dependent on acceptable base claims and that Examiner's rejections of these claims in view of either of Allamon alone or Allamon in view of Pia *et. al.* or McGarian *et. al.* should be withdrawn.

Turning to the rejection of Claim 7 under 35 U.S.C. 112, the dependency of Claim 7 has been amended so that Claim 7 now depends from Claim 5, and not Claim 1. It is submitted that this rejection of Claim 7 should therefore now be withdrawn.

Examiner objected to Claims 18, 19 and 21 as being dependent on a rejected base claim, but indicated that these claims would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claim. Accordingly, new Claims 23, 24 and 25 have been presented, based respectively upon old Claims 14, 15 and 18; Claims 14, 15 and 19; and Claims 14, 15 and 21. The Applicant therefore submits new Claims 23-25 are allowable in view of Examiner's comments on old Claims 18, 19 and 21.

Examiner will additionally note that certain minor amendments have been made to the

Specification, to clarify minor informalities and typographical errors. Applicant submits that the amendments serve merely to clarify the Specification, and that the amendments either have basis in the Application as originally filed, or that it is clear nothing other than the amendment requested was intended.

Applicant respectfully submits that the present Application is now in order for acceptance, and requests favourable reconsideration thereof. If it would aid in the disposition of this matter, the Examiner is kindly requested to contact the undersigned.

Respectfully Submitted,

21-Jan-2008
Date

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Substitute Specification (marked-up version):

TITLE OF THE INVENTION

Circulation Tool

CROSSREFERENCE TO RELATED APPLICATIONS

This application claims priority from PCT/GB2004/002806, having an international filing date of 30 June 2004, and a priority date of 1 July 2003.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT:

Not Applicable

THE NAMES OF THE PARTIES TO A JOINT RESEARCH AGREEMENT:

Not Applicable

INCORPORATION-BY-REFERENCE OF MATERIAL SUBMITTED ON A COMPACT DISC.:

Not Applicable

BACKGROUND OF THE INVENTION

The present invention relates to a downhole tool for circulating fluid in a well bore and in particular, though not exclusively, to a circulation tool which can be selectively locked in an opened or closed configuration while in tension or compression.

At various times during the drilling, completion and production of an oil or gas well, it may be necessary to circulate fluid within the well bore. This is typically done by running a tool on a workstring, the tool having a cylindrical body with radial ports, through which fluid from the bore of the workstring can pass. The procedure can provide a cleaning action and/or provide a transport system to carry debris and other materials from the well bore to the surface in the circulating fluid.

A known circulating tool is that disclosed in GB 2272923. This tool for circulating fluid in a well bore comprises a body member having a radial fluid outlet. An isolation sleeve is movably mounted on the body member for movement between an open position in which fluid may flow out of the outlet and a closed position. The isolation sleeve is moved to its open position against the action of spring by engaging a shoulder with the top of a liner and setting down on the tubing string. Alternatively, the outlet is opened when the lower end of the tubing string engages the bottom of the well bore.

This tool has a number of disadvantages. The tool can operate only by contacting a formation in the well bore e.g. a liner top or bottom of the well, and thus cannot be operated at any desired location in the well bore. In contacting a formation the tool is held in compression which limits other functions which can be performed from the work string when fluid is circulated through the tool. Further any spurious debris in the well bore, or indeed sudden pressure changes within the well bore can cause the tool to operate prematurely.

US 6,152,228 provides a circulation tool which overcomes the problem of premature operation. The tool comprises a tubular assembly which has an axial through passage between a fluid inlet and first fluid outlet. The fluid inlet and the first fluid outlet are connected in a work string which is supported from the surface above the well bore. There is a second outlet which extends generally transversely of the assembly. An obturating member is moveable between a first position

in which the second fluid outlet is closed and a second position which permits fluid flow through the second outlet. An engagement mechanism is moveable between an engaged configuration in which the obturating member is maintained in one of the first and second positions, and a disengaged configuration in which the obturating member is in the other of the first and second positions. The tubular assembly is coupled to a shoulder which is engageable with the formation in the well bore to engage or disengage the engagement mechanism. Setting down weight on the work string causes a formation of the well bore to exert a force on the shoulder which results in the second outlet being opened.

As the engagement mechanism allow the tool to be maintained in either the open or closed configuration, the tool cannot be prematurely set. However, the major disadvantage of this tool is that its use is limited to locations within the well bore where a formation exists so that the tool must be placed in compression to switch configuration.

It is an object of the present invention to provide a circulation tool which can be selectively opened and closed without the need to set down weight on the tool or contact a formation in the well bore.

It is a further object of at least one embodiment of the present invention to provide a circulation tool which can be locked in an open or closed configuration to operate the tool in tension or compression.

It is a still further object of at least one embodiment of the present invention to provide a method of operating a circulation tool by varying fluid pressure through the tool from pumps located above the tool.

SUMMARY OF THE INVENTION

According to a first aspect of the present invention there is provided a tool for circulating fluid in a well bore, the tool comprising a tubular assembly having a through passage between an inlet and a first outlet, the inlet and first outlet being adapted for connection in a work string, a second outlet extending generally transversely of the tubular assembly of the tubular assembly;

an obturating member moveable between a first position closing the second outlet and a second position permitting fluid flow through the second outlet, the obturating member including restraining means to actively retain the obturating member independently in the first and the second positions;

an engagement mechanism actuable between an engaged configuration, in which the obturating member is locked in one of the first or second positions; and a disengaged configuration in which the obturating member can move to the other of the first and second positions;

a fluid pressure actuation surface coupled to the engagement mechanism and biased by a spring located between the tubular assembly and the engagement mechanism;

wherein variation of fluid pressure on the actuation surface controls actuation of the engagement mechanism and stroking the tool in the disengaged configuration moves the obturating member.

Preferably the obturating member comprises a sleeve axially slidable within the tubular assembly. Preferably the restraining means is a collet. The collet may be retainable in a plurality of recesses on the tubular assembly.

Preferably the fluid pressure actuation surface is located on an actuator sleeve axially slidable within the tubular assembly. More preferably a portion of the actuator sleeve can locate across the collet.

Preferably the engagement mechanism comprises mutually engageable formations on each of the actuator sleeve and the tubular assembly. More preferably the formations comprise a pin and a groove. Advantageously the groove is continuous so that the pin can travel in a continuous cycle around the groove. Preferably the groove comprises a plurality of apexes and bases such that the pin moves longitudinally to the tubular assembly. The distance of longitudinal travel will determine whether the engagement mechanism is in the locked or disengaged position.

Preferably also the second outlet comprises a plurality of ports in the tubular assembly which communicate with the inlet. Typically the ports may be distributed circumferentially around the outer surface of the tubular assembly.

Typically the cross-sectional area of the first outlet is greater than the cross-sectional area of the second outlet.

The ports may be designed to direct the fluid exiting the second outlet in an uphole or downhole direction into the well bore.

According to a second aspect of the present invention there is provided a method for circulating fluid in a well bore, the method comprises the steps:

(b) inserting a work string into the well bore, the work string having a fluid inlet, a first fluid outlet and a second fluid outlet, an obturating member which is moveable between a first and second position to respectively close and open the second fluid outlet, and an engagement

mechanism which when engaged locks the obturating member in one of the first or second positions;

(c) varying the fluid pressure through the work string to move the engagement mechanism between locked and unlocked configurations; and

(d) stroking the work string to move the obturating member between the first and second positions.

Preferably varying the fluid pressure through the work string is achieved by pumping fluid through the work string.

Preferably the method includes the step of running the work string in a closed and locked configuration with the pumps turned off.

Preferably the method includes the step of drilling with the work string in a closed and locked configuration and in compression while pumping fluid.

Preferably the method includes the step of back reaming with the work string in a closed and unlocked configuration and in tension while pumping fluid.

Preferably also the method includes the step of opening the second outlet with the work string in tension with the pumps off.

Preferably also the method includes the step of stroking the work string in a locked and open configuration while pumping fluid.

Preferably also the method includes the step of stroking the work string in a locked and open

configuration with the pumps off.

Preferably the method includes operating the work string in a cyclic manner through the following configurations:

(g) locked closed;

(h) unlocked closed;

(i) unlocked open;

(j) locked open;

(k) unlocked open; and

(l) unlocked closed.

BRIEF DESCRIPTION OF THE DRAWINGS

An embodiment of the present invention will now be described, by way of example only, with reference to the following drawings of which:

Figure 1 is a part cross-sectional view of a tool for circulating fluid in a well bore according to an embodiment of the present invention;

Figure 2 is a schematic view of the profile of the groove in the index sleeve of the tool of Figure 1;

Figure 3 is a view through the section line A-A' of Figure 1; and

Figure 4 is a part view through the section line B-B' of Figure 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Reference is initially made to Figure 1 of the drawings which illustrates a tool, generally indicated by reference numeral 10, for circulating fluid in a well bore. Tool 10 has an upper end 12 comprising a top sub 14 being a cylindrical body and including a box section 16 for connecting the tool 10 to a work string or drill string. Located below the top sub 14 and connected thereto is a spring housing 18. Spring housing 18 is a substantially cylindrical body whose inner surface 20 includes a shoulder 22 against which a spring 24 is located. A radial port 26 is arranged through the spring housing 18 through which an index pin 28 is located. Though only a single index pin 28 is shown, more than one index pin may be used. In the preferred embodiment two index pins 28 are arranged opposite each other.

Located below the spring housing 18 and connected thereto is a collet housing 30. Collet housing 30 comprises a tubular body with an inner surface 32. Arranged on inner surface 32 are two concentric recesses 34,36. ~~Arrange~~ Arranged through the body are radial ports 38. In the preferred embodiment there are four radial ports arranged equidistantly around the housing body. A further access port 40 is provided in the housing 30 through which a plug and grease nipple arrangement 42 is positioned.

Located below the collet housing and connected thereto is a hex drive 44. Hex drive 44 comprises a cylindrical body having an inner surface 46 of which a portion 48 is hexagonal. At an upper end of the portion 48 is located a ledge 50. The hex drive 44 is positioned over a bottom sub 52 which extends therefrom. Bottom sub 52 includes a pin section 54 at a lower end for connection into a work string or drill string. A shoulder 62 is located to engage the ledge 50. The sub 52 also includes a hexagonal mating portion 56 to match the portion 48 on the hex drive 44. This is shown with the aid of Figure 3 which demonstrates the hex profile matching between the hex drive 44 and the bottom sub 52. In this way rotation of the hex drive 44 will be transmitted to the bottom sub 52.

The top sub 14, spring housing 18, collet housing 30, hex drive 44 and bottom sub 52 provide an outer surface 58 to the tool 10 while principally defining a central bore 60 through the tool for fluid communication with the work string. Rotation of the work string will be transmitted through the entire assembly regardless of whether fluid is being circulated out of the tool.

Arranged within the central bore 60 against the collet housing 30 is a collet assembly 64. Assembly 64 is substantially cylindrical to allow the passage of fluid through the central bore 60. The assembly includes, at its upper end eight sprung pins 66 which are biased in an outwardly radial direction. These pins 66 are shown in cross-section in Figure 4, illustrating the bulbous heads which are sized to fit within recess 34 or recess 36 on the collet housing 30. Assembly 64 includes radial ports 68 arranged equidistantly around and through the assembly 64. Preferably there are four ports 68 to match the four ports 38 on the collet housing 30. The collet assembly 64 is located against the housing 30 to provide a channel 70 around the ports 68. The channel is sealed via a wear ring 72 and o-rings 74 located at each end of the channel 70. The channel 70 allows the ports 68, 38 to be near alignment for fluid to flow from the central bore 60 to the outer surface 58 of the tool 10. A further set of o-rings 76 are located between a lower end of the assembly 64 and the housing 30 such that, when the ports 68, 38 are sufficiently misaligned and the passage for fluid is blocked, the ports 38 on the housing 30 are sealed to prevent the ingress of fluid between the housing 30 and the assembly 64.

Also located within the bore 60 is a collet support sleeve 78. Sleeve 78 is sized to locate over the sprung pins 66 of the collet assembly 64 and hold them in place within recess 34 or recess 36 as desired. The sleeve 78 can also locate above the collet assembly 64 leaving the pins 66 free to move within the central bore 60 against the inner surface 32 of the collet housing 30. An upper end 80 of sleeve 78 is connected to an actuator sleeve 82. The connection includes a bearing ring. Thus

sleeve 78 is moved by virtue of actuation of the actuator sleeve 82. Actuator sleeve 82 has an inner surface 84 located against the central bore 60. At an upper end 86 of the sleeve 82 is a conical surface 88. Surface 88 is a fluid pressure actuated surface. At the base of the surface 88 is located a choke ring 90. Surface 88 and choke ring 90 together ensure that variations in fluid pressure through the central bore 60 can cause movement of the actuator sleeve 82. At the upper end 86 facing the inner surface 20 of the spring housing 18 is a shoulder 92. Shoulder 92 is oppositely opposed to shoulder 22 of the spring housing 18. Between the shoulders 22,92 is arranged the spring 24. The shoulder 22 is fixed and thus movement of the actuator sleeve 82 downward is against the bias of the spring 24.

Adjacent the spring 24, between the actuator sleeve 84 and the spring housing 18 is located a cylinder sleeve 94. O-rings 96 seal the cylinder sleeve 94 against the actuator sleeve 84 but they do not prevent relative movement occurring between the sleeves. Cylinder sleeve 94 is held in position by virtue of the index pin 28 located through the access port 26 on the spring housing 18. Pin 28 locates through the cylinder sleeve 94 and into an index sleeve 98. Index sleeve 98 is located in a recess 100 of the actuator sleeve 84 with bearing rings located at each end thereof. Thus movement of the actuator sleeve 84 can move the index sleeve 98 and likewise arrest of the index sleeve 98 can prevent movement of the actuator sleeve 84. Additionally the index sleeve 98 can rotate without the rotating the actuator sleeve 84.

On an inner surface 102 of the index sleeve 98 is located a groove or profile 104. This is best seen with the aid of Figure 2 which shows the developed circumference of the index sleeve 98. In the Figure shown there are two index pins 28 making an identical path through the profile 104. The index pins 28 are shown located in a small apex 106. Actuation on the sleeve 98 will cause the pins to move to a first base 108. The bias on spring 24 will move the pins 28 to a high apex 110 providing the greatest longitudinal movement of the sleeve 98. On return the pins will locate in a

second base 112. As will be appreciated the pins 28 can cycle continuously around the sleeve 98 and consequently the movement of the actuator sleeve 84 can be controlled. When the pins 28 are located in the small apex the actuator sleeve 84 is effectively locked in position. A longitudinal wall on the first base side prevents accidental movement into the high apex 110, and movement in the opposite direction causes the pin 28 to fall into the second base 112.

In use, the tool is inserted into a a drill string and connected thereto by use of the box section 16 and the pin section 54. We will describe the operation of the tool cycling from a closed and locked position to an identical position. It will be understood that the tool can be cycled from any starting position in the cycle and thus the tool run into a well bore in any configuration and pulled from the well bore in any configuration.

Additionally it will be appreciated that although the description has referred to terms such as upper, lower, above, below, these are all relative. The tool of the present invention finds equal application in non-vertical wells such as those that are inclined or horizontal.

The tool 10 is run on the drill string into the well bore in a locked closed configuration. In this configuration the index pins 28 are located in the small apex 106 of the profile 104 on the index sleeve 98. This 'locks' the index sleeve 98 in position and with it the actuator sleeve 84 and the collet support sleeve 78. Collet support sleeve 78 extends over the sprung pins 66 of the collet assembly 64 and thus holds the sprung pins 66 in the upper recess 34. Radial ports 68 and 38 are thus misaligned and the tool is 'closed'. Fluid flow is only through the central bore 60.

In order for drilling to take place from the end of the drill string, fluid is required to be pumped through the central bore. The drilling action compresses the drill string and thus the tool 10 is in compression. Fluid pressure on the pressure surface 88 causes movement of the actuator sleeve

and with it the index sleeve 98. Index pin 28 moves to the first base 108 and the compression prevents it from moving into the high apex 112. Loading within the tool is on the shoulder 62. This effectively is a downstroke. The tool remains locked and closed. On the upstroke, occurring when drilling stops and back reaming for instance starts, the drag forces created by the weight of tools on the string below tool 10 causes tool 10 to go into tension. The index pin 28 remains in the first base 108 and the tool is still in the locked and closed position. Loading, however, has shifted from shoulder 62 to the sprung pins 66 against the recess 34.

Turning the pumps off to lower fluid pressure in the tool 10 and again stroking the tool, causes the collet support sleeve 78 to raise and clear the sprung pins 66 on the downstroke and move the sprung pins 66 to the lower recess 36 on the upstroke. The index pin 28 is now located in the high apex 110. Movement of the sprung pins 66 to the lower recess 36 causes lowering of the collet assembly 64 within the tool 10. Channel 70 now locates across the radial ports 38 and fluid can thus circulate from the bore 60 through the ports 68 and out of the tool 10 to the outer surface 58 via ports 38. The tool 10 is 'open'.

To 'lock' the tool 'open' the pumps are turned on and pumping is maintained at a sufficiently high rate to cause movement of the actuator sleeve 84 against the spring 24 by fluid pressure on the pressure surface 88. The collet support sleeve 78 moves across the sprung pins 66 to hold them in the lower recess 36. Index pin 28 is moved to the second base 112. The ports will remain open in this configuration even if the tool 10 is moved up and down in a well bore or back and forth in an inclined well bore. ~~Stoking~~ Stroking the tool merely switches loading between the sprung pins 66 on the recess 36 and the top of the hex drive 44.

When the pumps are turned off in this configuration the tool 10 will remain 'open' and 'locked' as the only movement occurring is the index pin 28 moving into the small apex 106.

To reset, the tool 10 is placed in tension and picked-up on the upstroke. This releases the collet support sleeve 78 from the sprung pins 66 and allows them to move back to recess 34. Switching on and off of the pumps with a downstroke will return the tool 10 to the 'locked' and 'closed' configuration. The cycle can be resumed from this point whenever fluid circulation from the tool 10 is required. Alternatively the tool can be pulled out of the well bore on the string.

The principal advantage of the present invention is that it provides a tool for circulating fluid in a well bore which can be operated without the need to land the tool on a formation. This allows the tool to be operated in inclined or horizontal well bores. This provides the further advantage that the tool can be operated on a drill string so that circulation can be used to sweep cuttings from the bit back to the surface of the well. Jetting fluid from the tool can also held clear blockages in the well bore.

A further advantage of the present invention is that it provides a tool which can be locked in the open or closed position whether the tool is placed in tension or compression. Additionally the hex drive allows other tools to be operated below the tool regardless of the configuration of the tool.

Further modifications may be made to the invention hereindescribed without departing from the scope thereof. For example, The actuator sleeve and the index sleeve could be a unitary piece. The collet assembly could comprise two sleeves, the first including the sprung pins and the second including the radial ports, with the first sleeve acting on the second to open the ports.